EFFECT OF ALUMINIUM OXIDE AND SILICON CARBIDE ABRASIVE TYPE ON MILD STEEL SURFACE TEMPERATURE

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SUPERVISOR DECLARATION

I hereby declare that I had read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the purpose of the granting of Bachelor of Mechanical Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurently submitted for award of other degree.

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ABSTRACT

Surface grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat surfaces by removing a small amount of material. The phenomena of removing process actually will lead to the thermal damage to work piece and wheel grinder. As a result, this study tends to investigate the optimum parameter on mild steel grinding process by using conventional grinding machine through understanding the thermal effect and temperature distribution in the process and to investigate the thermal process of the mild steel grinding process for different parameter by using aluminum oxide and silicon carbide as a wheel grinder by running the experiment in dry grinding. A method of capturing the increasing temperature value is by using infrared thermometer. Depth of cut and table speed are the variables parameter used in this experiment and spindle speed and mode of dressing are the parameter that constant along the experiment are running. Furthermore, by using Taguchi approached, design of experiment (DOE) will be attained and Minitab software is used to design the DOE. Two way ANOVA methods then used to make an analysis of the data attained. The temperature value are analyzed to make the conformation that table speed and silicon carbide wheel grinder will give high impact to temperature rising. This research proved that by using silicon carbide as a grinding wheel, it will give higher thermal effect to the workpiece instead using aluminium oxide grinding wheel. Silicon carbide wheel grinder, that have rough grain will produce high friction force during grinding process occur. This friction force then will produce heat and will produce higher value of temperature instead using aluminium oxide. Aluminium oxide that have smaller grain, will also produce heat but the value of the temperature are smaller than using silicon carbide. After that, table speed is most significant factor that effect thermal on mild steel grinding process with silicon carbide as wheel grinder but for aluminium oxide wheel grinder, thermal effect are very low when using variables parameter.

ABSTRAK

Giling permukaan merupakan proses pengakhiran yang digunakan untuk memperbaiki permukaan akhir, mengelupas bahan keras, dan ketatkan toleransi pada permukaan datar dengan pengikisan sejumlah kecil material. Fenomena pengikisan ini akan menyebabkan kerosakan terma untuk bahan kerja dan roda penggiling. Oleh itu, kajian ini cenderung untuk menyiasat parameter optimum pada proses penggilingan besi karbon dengan menggunakan mesin penggiling konvensional melalui pemahaman kesan terma dan pengedaran suhu pada proses dan untuk menyiasat proses terma daripada proses penggilingan besi karbon untuk parameter yang berbeza dengan menggunakan aluminium oksida dan silikon karbida sebagai roda penggiling dengan menjalankan percubaan di penggilingan kering. Sebuah kaedah menangkap nilai peningkatan suhu adalah dengan menggunakan termometer IR. Kedalaman potong dan kelajuan meja parameter pembolehubah yang digunakan dalam percubaan ini dan spindel kelajuan dan cara berpakaian adalah parameter yang malar di sepanjang percubaan berjalan. Selain itu, dengan menggunakan kaedah Taguchi, penyusunan eksperimen (DOE) akan digunakan dan software Minitab digunakan untuk desain DOE. Kaedah ANOVA dua arah kemudian digunakan untuk melakukan analisis data tercapai. Nilai suhu dianalisis untuk membuat konformasi yang jadual kelajuan dan silikon karbida roda penggiling akan memberikan kesan kenaikan suhu tinggi. Penelitian ini membuktikan bahawa dengan menggunakan silikon karbida sebagai roda penggiling, maka akan memberikan kesan terma yang lebih tinggi kepada benda kerja berbanding menggunakan aluminium oksida roda penggiling. Roda penggiling silicon karbida, yang mengandungi butir kasar akan menghasilkan gaya gesekan tinggi selama proses grinding berlaku. Geseran ini kemudian akan menghasilkan suhu panas dan akan menghasilkan nilai yang lebih tinggi daripada suhu dariapada menggunakan aluminium oksida. Aluminium oksida yang mengandungi butir yang lebih kecil, juga akan menghasilkan panas tapi nilai suhu lebih kecil daripada menggunakan silikon karbida. Setelah itu, kelajuan meja faktor paling penting yang mempengaruhi panas pada proses penggilingan baja ringan dengan silikon karbida sebagai penggiling roda tetapi untuk penggiling roda aluminium oksida, kesan terma yang sangat rendah apabila menggunakan parameter pembolehubah.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material.

In grinding, an abrasive material rubs against the metal part and removes tiny pieces of material. The abrasive material is typically on the surface of a wheel or belt and abrades material in a way similar to sanding. On a microscopic scale, the chip formation in grinding is the same as that found in other machining processes. The abrasive action of grinding generates excessive heat so that flooding of the cutting area with fluid is necessary. Grinding process is indeed given priority to do the surface finish on the material because of some particular reasons :

1. The material is too hard to be machined economically. (The material may have been hardened in order to produce a low-wear finish, such as that in a bearing raceway.
2. Tolerances required preclude machining. Grinding can produce flatness tolerances of less than ±0.0025 mm (±0.0001 in) on a 127 x 127 mm (5 x 5 in) steel surface if the surface is adequately supported.
3. Machining removes excessive material.

In industry, grinding usually used in automotive production. Grinding is used to make surface finished on car body

1.2 PROJECT BACKGROUND

The grinding machine consists of a power driven grinding wheel spinning at the required speed (which is determined by the wheel's diameter and manufacturer's rating, usually by a formula) and a bed with a fixture to guide and hold the work-piece. The grinding head can be controlled to travel across a fixed work piece or the workpiece can be moved whilst the grind head stays in a fixed position. Very fine control of the grinding head or tables position is possible using a vernier calibrated hand wheel, or using the features of numerical controls. Grinding machines remove material from the workpiece by abrasion, which can generate substantial amounts of heat; they therefore incorporate a coolant to cool the workpiece so that it does not overheat and go outside its tolerance. The coolant also benefits the machinist as the heat generated may cause burns in some cases. In very high-precision grinding machines (most cylindrical and surface grinders) the final grinding stages are usually set up so that they remove about 200nm (less than 1/100000 in) per pass - this generates so little heat that even with no coolant, the temperature rise is negligible.

Table 1.0 : Type of grinding machine

Grinding machine	Applications
Belt grinder	Finishing, deburring, and stock removal
Bench grinder	Shaping tool bits or various tools that need to be made or repaired. Bench grinders are manually operated.
Cylindrical grinder	Make precision rods
Surface grinder	To clean the surface of workpiece. Can be manually operated or have CNC controls.
Tool and cutter grinder and the D-bit grinder	These usually can perform the minor function of the drill bit grinder, or other specialist toolroom grinding operations
Jig grinder	Its primary function is in the realm of grinding holes and pins. It can also be used for complex surface grinding to finish work started on a mill.

1.3 PROBLEM STATEMENT

During grinding, a number of physical phenomena occur ; cutting, sliding, material removal, heat generation, deformation, fluid flow, etc. When grinding process is started, frictional force between grinding tool and workpiece will generate heat that can effect the quality of workpiece and also damage the tool. A central problem during the grinding process is especially the thermal stress on the tools. If the process temperatures are too high, certain application properties can be modified and lasting damage to the tools can possibly result, such as, e.g microstructures change or micro cracks. The influence exerted on the cutting tool material becomes especially clear when grinding cermets. Here high temperature, temperature gradients and thermo mechanical stresses can arise, leading to the damage such as appearance of cracks. When the tool is used later, these cracks can cause lasting detrimental effects on application and wear behavior.

1.4 OBJECTIVES

- To do the thermal analysis on mild steel grinding process by using conventional grinding machine
- To determine the significant parameter that effect on tool and workpiece by using different parameter
- To investigate the thermal process of the mild steel grinding process for different parameter by using aluminum oxide and silicon carbide as a wheel grinder.

1.5 SCOPE OF PROJECTS

- Using mild steel as a workpiece study
- Using aluminium oxide and silicon carbide as a wheel grinder in dry grinding
- Using thermometer infrared to measure temperatures in the workpiece surface during grinding
- The wheel speed will remain constant until experiment are completed

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION OF GRINDING

There are several processes of manufacturing that are important for the conversion of raw materials into finished goods. Most of these processes deal with giving a new shape and form to the raw materials either by changing their state or shape [2]. One such important process is grinding, and it is very useful technique for metal removal at fast rates and for the high level finishing of final products.

2.1.1 Grinding

Basically grinding is nothing but removal of metal at a much faster rate than was earlier done with single edge tools such as chisels. Of course, grinding can be compared to a cutting tool such as a file having multiple edges rather than a chisel with a single edge, but with a much greater speed, material removal, accuracy, and surface finish. However, at the same time it must be noted that it is more appropriate to link grinding to a finishing process rather than a manufacturing process, in the true sense of the word, though these terms are used alternatively in common usage. Apart from being used as material removal process, it is also used to sharpen the cutting edges of cutting tools and sharp objects such as knives, although the underlying process of material removal is the same, but with a different purpose - to produce a sharp edge rather than to reduce size [10].

The grinding wheel consists of several abrasive particles which act as minute cutting edges, and these particles are bonded with the help of bonding material. The advantage of using such a process over conventional metal removal processes are as follows

- The rate of removal of material is much higher than a traditional file
- The surface finish obtained is obviously much better than can be obtained through a chisel or a file
- It is very difficult to remove metal from a surface when it is hardened, and grinding is one of the most practical solutions in such cases
- The pressure required for the grinding process is very small, which means that it is easier to hold the metal even during automated process though use of simple techniques such as magnetic chucks

It is very important that we choose the correct grinding wheel for the exact type of cutting required. The manner of cutting should also be proper, as otherwise the grains may get over-worn resulting in less cutting action or the chips getting embedded in the wheel itself. In the next article we will take a look at various types of abrasive materials which are used for the manufacture of cutting particles in the grinding wheels and the use of both natural as well as artificial materials for the same.

2.1.2 Surface grinding

In this research, surface grinding is used because it is the most common operation of grinding for the flat surfaces. Workpiece is secured on a magnetic chuck attached to the work table of the grinder and for nonmangetic material, vises, vacuum chucks or some other fixtures is used to hold the workpiece [1]. Surface grinding methods include: horizontal-spindle, vertical-spindle, vertical-spindle rotary grinding, horizontal spindle single disk, and vertical swivel head grinding. Parts may require surface grinding for several reasons. The following are a few of the more common reasons:

- Produce a very flat surface.
- Very accurate thickness tolerance specified.
- A very smooth surface roughness Ra is specified/required.

- Cutting tool sharpening

Surface grinding machines and processes where first developed to manufacture very tight tolerances, smooth surface finishes, and removing material from very hard materials.

Figure 2.0 and 2.1 showed model of flat surface grinding machine avaiable at FKM lab.

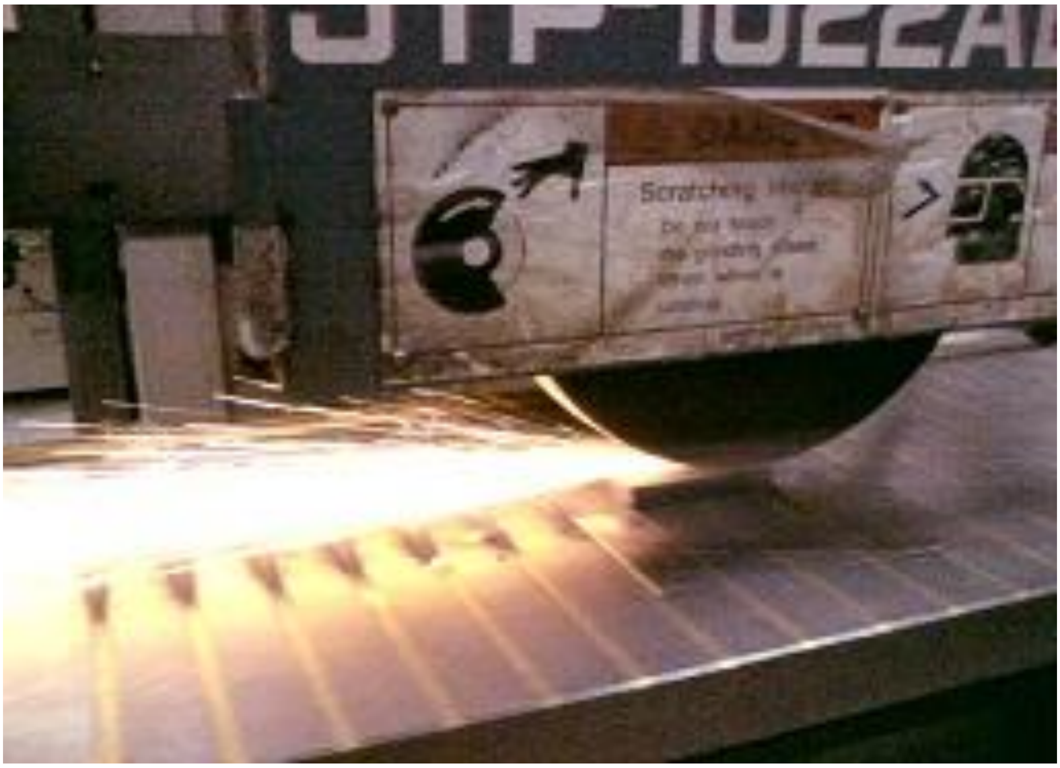

Figure 2.0: Horizontal-spindle reciprocating table surface grinding

Figure 2.1 : Surface grinding machine

2.1.3 Grinding machine

The grinder is a machine that is used for fine surface finishing and the amount of material removed rarely exceeds a few thousands of an inch. These machines have been developed over the years to satisfy specific needs of the industry it serves, so grinding has become specialized, as has turning and milling. The most common types of grinders are the surface grinder, the universal tool and cutter grinder, and the cylindrical grinder [11].

Figure 2.2 : Surface grinder

Figure 2.3 : Cylindrical grinder

Table 2.0 : Grinding machine specification [1]

Process	**Characteristics**	**Typical maximum dimensions,length and diametet,m**
Surface	Flats surfaces on most materials;production rate depends on the table size and level of automation;labor skill depends on part complexity;production rate is high on vertical – spindle rotary – table machines	Reciprocating table L:6 Rotary table D: 3
Cylindrical	Round workpieces with stepped diameter ; low production rate unless automated;	Workpiece D: 0.8, roll grinder D: 1.8, universal grinder D: 2.5
Centerless	Round and slender workpieces; high production rate; low to medium labor skill	Workpiece D: 0.8
Internal	Holes in workpiece; low production rates; low to medium labor skill	Hole D: 2
Honing	Holes in workpiece; low production rates; low labor skill	Spindle D: 2
Lapping	Flat, cylindrical or curved; high production rate; low labor skill	Table D: 1.2
		-

2.1.4 Grinding wheel

Grinding wheels use several types of abrasive grains. Aluminum oxide, the most common industrial mineral in use today, is used either individually or with other materials to form ceramic grains. Silicon carbine, a synthetic abrasive that is harder than aluminum oxide, is typically used with nonferrous materials such as brass, aluminum, and titanium. Alumina-zirconia grains fuse aluminum oxide and zirconium oxide and are used to improve grinding performance on materials such as stainless steel. Synthetic diamond superabrasives are used for grinding nonferrous metals, ceramics, glass, stone, and building materials. Cubic boron nitride (CBN), another type of superabrasive, provides superior grinding performance on carbon and alloy steels. CBN is second only to diamond in terms of hardness.

Crushed tungsten carbide grits are used in metal-bonded products to abrade tough materials such as composites, fiberglass, reinforced plastics, and rubber [12].

2.1.4.1 Aluminium Oxide

As an angular, durable blasting abrasive, aluminum oxide (or aluminium oxide) can be recycled many times. It is the most widely used abrasive grain in sand blast finishing and surface preparation because of its cost, longevity and hardness. Harder than other commonly used blasting materials, aluminum oxide grit powder penetrates and cuts even the hardest metals and sintered carbide.

Approximately 50% lighter than metallic media, aluminum oxide abrasive grain has twice as many particles per pound. The fast-cutting action minimizes damage to thin materials by eliminating surface stresses caused by heavier, slower cutting media.

Aluminum oxide grit powder has a wide variety of applications, from cleaning engine heads, valves, pistons and turbine blades in the aircraft industry to lettering in monument and marker inscriptions. It is also commonly used for matte finishing, as well as cleaning and preparing parts for metalizing, plating and welding.

Aluminum oxide abrasive grain is the best choice for an abrasive sand blasting and polishing grain as well as for preparing a surface for painting.

Figure 2.4 : Aluminium oxide wheel grinding

Table 2.1 : Aluminium oxide grinding wheel types

Name	Colouration	Al_2O_3 contents	Machined materials
Aluminium oxide 95A	grey-blue or brown	ca. 94,5%	carbon steels C< 0,5%; cast steels, malleable cast irons, and some non-iron materials.
Aluminium oxide 97A	grey-brown or grey-blue	ca. 97,5%	alloy and carbon steels with 0,5% contents of carbon and hardness up to 60HRC
Aluminium oxide 99A (38A)	white	more than 98%	alloy and carbon steels with more than 0,5% contents of carbon and hardness above 62HRC.
Microcrystalline aluminium oxide 32A	bright pink	more than 98%	alloy and carbon steels with more than 0,5% contents of carbon and hardness above 62HRC.

Table 2.1: Aluminium oxide grinding wheel types (cont...)

Microcrystalline aluminium oxide - Cubitron SG	blue	ca. 95%	stainless steels, titan, chrome and nickel alloys.
Microcrystalline aluminium oxide - Cerpass XTL	white	ca. 99,6%	stainless steels, titan, chrome and nickel alloys.

In this researh, the aluminium oxide type that has been used in mild steel grinding process is microcrystalline aluminium oxide 32A.

2.1.4.2 Silicon Carbide

Silicon carbide is the hardest blasting media available. High-quality silicon carbide media is manufactured to a blocky grain shape that splinters. The resulting silicon carbide abrasives have sharp edges for blasting. Silicon carbide has a very fast cutting speed and can be recycled and reused many more times than sand. The hardness of silicon carbide allows for much shorter blast times relative to softer blast media.

Silicon carbide grit is the ideal media for use on glass and stone in both suction or siphon and direct pressure blast systems. The ability to be recycled multiple times results in a cost-effective silicon carbide grit blast media with optimal etching results. Since silicon carbide grit is harder than aluminum oxide, it can be used efficiently for glass engraving and stone etching. Silicon carbide grit blast media has no free silica, does not generate static electricity and is manufactured to contain minimal magnetic content.

Figure 2.5 : Silicon Carbide wheel grinding

Table 2.2 : Silicon carbide grinding wheel types

Name	Colouration	SiC contents	Machined materials
Green silicon carbide 99C	dark green	99,66%	HSS cutting tools, cemented carbides, ceramics and for truing and dressing.
Black silicon carbide 98C	black	98,26%	hardened and grey cast iron, cemented carbides, non-ferrous materials, glass, plastics, leather and rubber.